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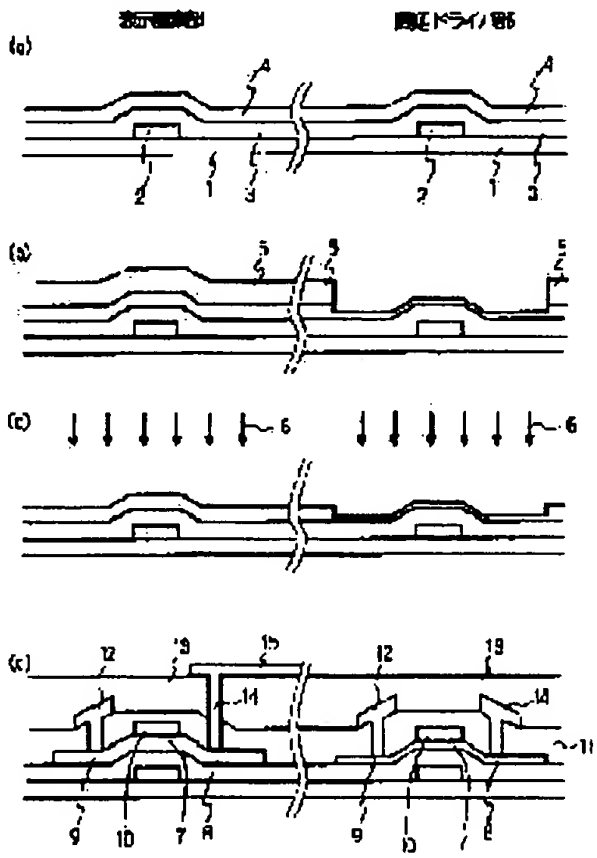
(54) THIN FILM TRANSISTOR, MANUFACTURE OF THE SAME AND DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide TFT to which different electrode field shift degrees are requested on the same substrate, by constituting a plurality of thin film transistors of thin film transistors provided with active layers having prescribed thickness, and thin film transistors provided with active layers having thickness different from prescribed thickness.
SOLUTION: A gate electrode 2 formed of high melting point metal, a gate insulating film 3 formed of a SiN film and a SiO2 film and an amorphous silicon film 4 are sequentially formed on an insulating substrate 1. A resist pattern 5 is formed so that it covers an area except for an area where the amorphous silicon film 4 of a peripheral driver part area is formed. The amorphous silicon film 4 of a peripheral driver part is etched and the thickness of the amorphous silicon film 4 of the peripheral driver part becomes thinner than that of the amorphous silicon film of a display picture element part. The resist pattern 5 is removed and the amorphous silicon films 4 of the display picture element part and the peripheral driver part are irradiated with laser beams 6. Then, a polycrystalline silicon film is obtained and an active layer is constituted.



LEGAL STATUS

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to TFT which can control electric-field mobility easily about TFT ("TFT" is called Thin Film Transistor and the following.).
[0002]
[Description of the Prior Art] In recent years, the development of the so-called driver one apparatus LCD used as the display which prepared two or more TFT on the same substrate, for example, an active matrix liquid crystal display ("LCD" is called Liquid Crystal Display and the following.) driver element, and a display pixel driver element is furthered.
[0003] The conventional driver one apparatus LCD is explained below. The block diagram of conventional driver one apparatus is shown in drawing 5 . The display pixel section by which the display electrode was arranged in the shape of a matrix is prepared near the center section of the insulating substrate 1, and the display electrode is connected with the source electrode of TFT prepared in each display pixel. That is, each display electrode of the display pixel section is driven by TFT.
[0004] Moreover, the peripheral-driver section which consists of the X-axis driver and Y-axis driver which supply a scanning signal and a video signal to TFT of the display pixel section is prepared around the display pixel section. This peripheral-driver section consists of the shift register, and the shift register also consists of TFT. In this way, TFT is prepared in the display pixel section and the peripheral-driver section, respectively.
[0005] By the way, since high speed signal processing is required and high electric-field mobility, i.e., the high ON state current, is demanded, TFT which constitutes the peripheral-driver section among such TFT needs to give priority to the high electric-field mobility for this high-speed processing. Therefore, when TFT of the display pixel section and the peripheral-driver section is formed, using the same semiconductor layer, for example, a polycrystal silicon layer, as an active layer, polycrystal-ization of an active layer will be performed so that the ON state current of the peripheral-driver section may become high.
[0006]
[Problem(s) to be Solved by the Invention] However, when it does so, while the ON state current is high, the OFF state current will also become high. Therefore, a leakage current will generate TFT of the display pixel section. Then, in order to prevent this leakage current, considering as TFT structure of having the so-called double-gate electrode structure which established the two gates in one TFT and made resistance high as shown in drawing 6 is proposed.
[0007] However, since the two gates were formed while there was a fault that the rate of the viewing area to a display pixel, i.e., a numerical aperture, will fall, when the two gates were formed in one display pixel, there was a fault that the yield of TFT fell. In addition, although forming the active layer of TFT of the peripheral-driver section with polycrystal silicon, and forming the active layer of TFT of the display pixel section with amorphous silicon is also proposed in order to raise the electric-field mobility of TFT of the peripheral-driver section Since the wiring for making the display pixel section drive for that purpose and the driver circuit newly needed to be prepared, while it became the hindrance of the so-called ******-izing which makes small area of the peripheral-driver section without regards to a display, there was also a fault of becoming increase of a process.
[0008] then, in view of the above-mentioned conventional fault, it succeeds in this invention -- having -- activity -- while TFT of which different electric-field mobility is required by making thickness with that right into two or more kinds is realizable on the same substrate, it aims at offering high TFT, its manufacture technique, and display of a numerical aperture
[0009]
[Means for Solving the Problem] TFT of this invention is two or more TFT which it comes to form on the same substrate, and two or more of these TFT consists of the TFT equipped with the active layer which has predetermined thickness, and the TFT equipped with the active layer which has the thickness different from the aforementioned predetermined thickness.
[0010] The display of this invention is equipped with the 1st TFT which drives two or more display pixels and these display pixels on the same substrate, and the 2nd TFT which drives the 1st TFT around the aforementioned display pixel, and changes, and the thickness of the active layer of the 1st aforementioned TFT is thicker than the thickness of the active layer of the 2nd TFT.

[0011] The manufacture technique of the TFT of this invention includes the process which forms an amorphous-semiconductor layer on a substrate, the process which forms a covering field by the coating for a part of this amorphous-semiconductor layer, the process which etches and makes thin amorphous-semiconductor layers other than this covering field, the process which removes the aforementioned coating, and the process which irradiates laser, polycrystal-izes it to the aforementioned covering field and a

non-covering field, and is used as an active layer.
[0012] Moreover, the process which forms an amorphous-semiconductor layer on a substrate, the process which forms a covering field by the coating for a part of this amorphous-semiconductor layer, the process which carries out the laminating of the amorphous-semiconductor layer further on amorphous-semiconductor layers other than this covering field, the process which removes the aforementioned coating, and the process which irradiates laser, polycrystal-izes it to the aforementioned covering field and a non-covering field, and is used as an active layer are included.
[0013]
[Embodiments of the Invention] TFT of this invention is explained below. The manufacturing-process cross section of TFT of this invention is shown in drawing 1 , and the plan of TFT of the display pixel section is shown in drawing 2 . Drawing 1 shows the display pixel section to the left-hand side, and shows the manufacturing-process cross section of the peripheral-driver section to right-hand side.
[0014] Process 1(drawing 1 (a)): Form in order the gate insulator layer 3 and the amorphous silicon layer 4 which consist of the gate electrode 2, SiN layer, and SiO2 layer which consist of refractory metals, such as Cr and Mo, on the insulating substrate 1 which consists of quartz glass, an alkali free glass, etc.
Process 2(drawing 1 (b)): Form the resist pattern 5 so that it may be covered except the field in which the amorphous silicon layer of a peripheral-driver section field was formed.
[0015] Then, the amorphous silicon layer of the peripheral-driver section is etched by dry etching, such as RIE (Reactive Ion Etching:reactive ion etching). By this, the thickness of the amorphous silicon layer of the peripheral-driver section makes it thinner than the thickness of the amorphous silicon layer of the display pixel section.
Process 3(drawing 1 (c)): Remove the resist pattern 5 and irradiate laser 6 at the amorphous silicon layer of the display pixel section and the peripheral-driver section. At this time, since laser is irradiated simultaneously at the display pixel section and the peripheral-driver section, the laser of the same energy will be irradiated at the display pixel section and the peripheral-driver section. And an amorphous silicon layer is polycrystal-ized and it is made a polycrystal silicon layer. This serves as the active layer 4 of TFT.
[0016] process 4(drawing 1 (d)): -- the channel 7 of the gate electrode 2 upper part, and the source 8 and the drain 9 which the ion implantation was carried out to the both sides of the channel 7, and were formed in them are formed in the active layer 4 On a channel 7, the stopper 10 which consists of SiO2 layer which functions as ion not going into a channel 7 considering a channel 7 as a wrap mask at the time of the ion implantation at the time of forming the source 8 and the drain 9 is formed.
[0017] And the layer mesenteriolum 11 by which the laminating was carried out to the order of SiO2 layer, SiN layer, and SiO2 layer is formed the whole surface on the gate insulator layer 3, the active layer 4, and the stopper 8. Moreover, the contact hole established in the layer mesenteriolum 11 corresponding to the drain 9 is filled up with metals, such as aluminum, and the drain electrode 12 is formed in it. And the flattening layer 13 which consists of an organic resin is formed in the whole surface.
[0018] In the display pixel section, a contact hole is formed in the position corresponding to the source 8 of this flattening layer 13, and the display electrode 15 which is a transparent electrode which consisted of transparent electrical conducting materials, such as ITO in contact with the source 8, and served as the source electrode 14 is formed. In this way, each TFT of the display pixel section from which the thickness of an active layer is different on the same substrate, and the peripheral-driver section is completed.
[0019] In addition, although TFT which connected the display electrode 15 is prepared near the crossover of gate signal line G and drain signal D as shown in drawing 2 , the TFT is making the so-called single gate structure where the number of the gates is one. Here, the thickness and the diameter of crystal grain of an amorphous silicon layer of the active layer 4 are explained. The relation of the irradiation energy of laser and the diameter of crystal grain which irradiate drawing 3 is shown.
[0020] In this drawing, a quadrature axis shows the irradiation energy of the excimer laser which irradiates an amorphous silicon layer, and the axis of ordinate shows the diameter of crystal grain formed according to the irradiation energy of the laser. Moreover, the black-lacquered rectangular head in drawing (**) shows the case where the thickness of an amorphous silicon layer is 400A, a black-lacquered round head (-) shows the case where the thickness of an amorphous silicon layer is 350A, and the black-lacquered trigonum (**) shows the case where the thickness of an amorphous silicon layer is 300A.
[0021] In this drawing, when energy of an excimer laser is set to 595mJs and the thickness of an amorphous silicon layer is 400A, the diameter of crystal grain is as small as about 190nm, and when the thickness of an amorphous silicon layer is 300A, the diameter of crystal grain becomes large about 400nm. That is, when it is made the same irradiation energy, the diameter of crystal grain becomes [the direction which made the thickness of an amorphous silicon layer small] large. Therefore, the direction which made thickness of amorphous silicon small can make electric-field mobility high.
[0022] making amorphous silicon layer thickness of the display pixel section into 300A, and making it of the peripheral-driver section into 400A, although the electric-field mobility of TFT of the display pixel section and the peripheral-driver section was 80square-centimeter/(a bolt and second) conventionally -- the electric-field mobility of the display pixel section -- 40 square centimeters/(a bolt and second) -- moreover, the peripheral-driver section was able to be made into 80square-centimeter/(a bolt and second)
[0023] Thus, by making thickness of the active layer of the TFT thin in TFT of the peripheral-driver section as which high electric-field mobility is required, and making thickness of an active layer thicker than that of the peripheral-driver section in TFT of the display pixel section as which low electric-field mobility is sufficient compared with TFT of the peripheral-driver section, when laser radiation is carried out simultaneously, the electric-field mobility of TFT of the display pixel section and the

peripheral-driver section can be adjusted.

[0024] Moreover, since it becomes unnecessary to carry out TFT of the display pixel section double-gate structure while it can raise the voltage retention of TFT of the display pixel section, since TFT of the display pixel section whose electric-field mobility whose thickness of amorphous silicon is thick and is not so high can make the property, especially a leakage current small, it can raise the numerical aperture of a display pixel.

[0025] In addition, the cross section at the time of using above-mentioned TFT for LCD is shown in drawing 4 . The structure of TFT is the structure where the thickness of the active layer of the display pixel section is thicker than the active layer of the peripheral-driver section, like the publication to the above-mentioned drawing 1 , and the structure of LCD is the structure which filled up with liquid crystal 19 the opening which pastes up with the seal adhesives 18 and was formed [circumference] of both the substrates 1 and 17 in the insulating substrate 1 equipped with the TFT, and the opposite substrate 17 which has the counterelectrode 16 which countered this substrate

[0026] In addition, in the gestalt of this operation, although the case where thickness of the active layer of TFT was made into two kinds was explained, this invention may not be limited to it and may be the thickness of three or more kinds of active layers. Moreover, by forming an amorphous silicon layer on an insulating substrate in the gestalt of this operation, although the case where etched the opening and the part which makes an amorphous silicon layer thin was made thin as opening of a resist pattern was shown, an amorphous silicon layer may be formed on an insulating substrate, an amorphous silicon layer may be partially formed further in the part which thickens an amorphous silicon layer, and thickness may be controlled.

[0027]

[Effect of the Invention] While TFT of which a different property is required is realizable on the same substrate only by considering as the thickness from which the electric-field mobility which considers thickness of the active layer of TFT as a request is obtained according to this invention, high TFT, its manufacture technique, and display of a numerical aperture are obtained.

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* NOTICES *

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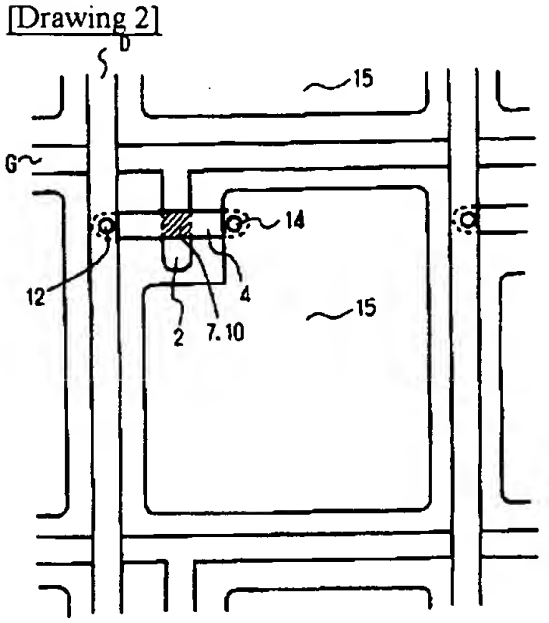
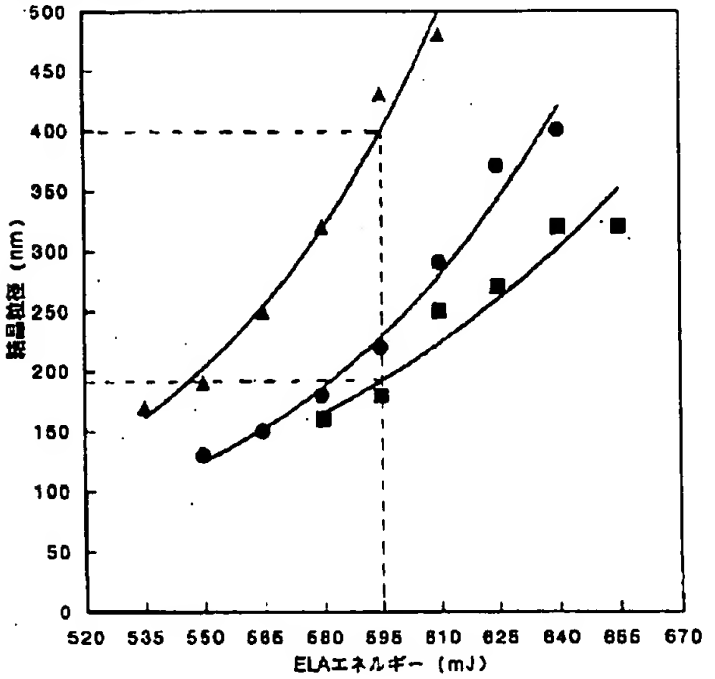
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

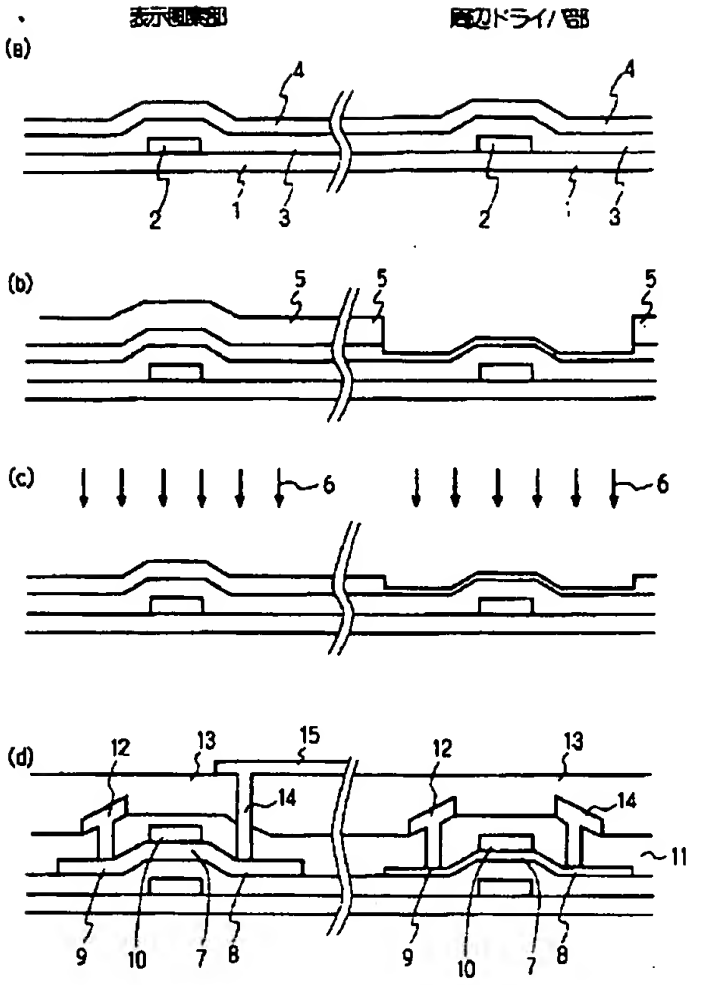
[Drawing 2]



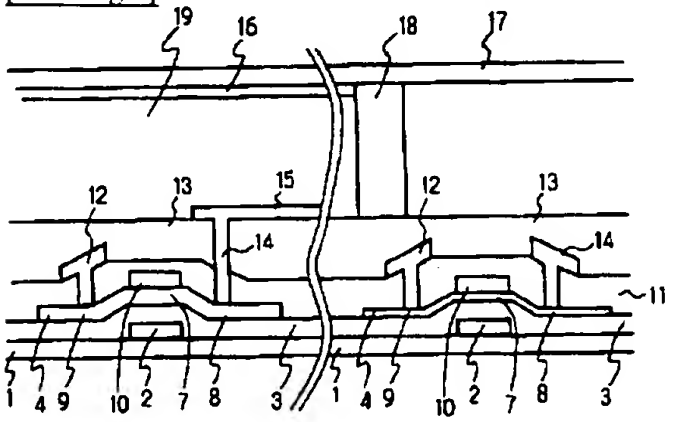
[Drawing 3]



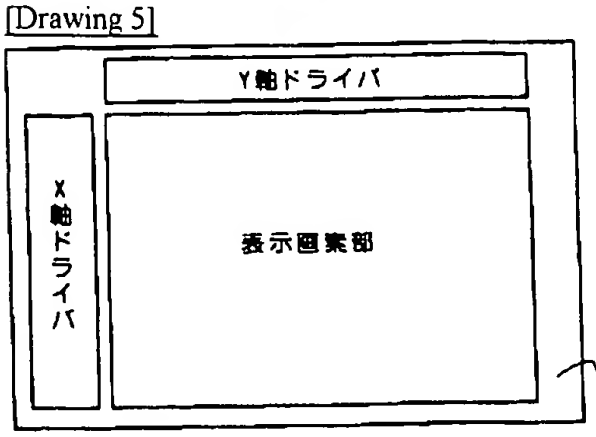
[Drawing 1]



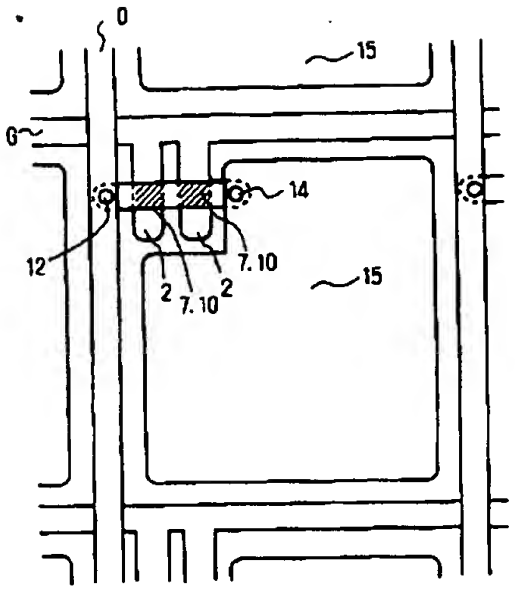
[Drawing 4]



[Drawing 5]



[Drawing 6]



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